



Digital Resilience

D2.2: DigitalResilience Curriculum

September 2025

Grant Agreement: 2024-1-ES01-KA220-HED-000252797

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DOCUMENT VERSION

Nr.	Description	Date	Author/s
01	Draft_V1	17/06/2025	Taylan Günay, Ph.D Özge Andiç Çakır, Ph.D Fırat Sarsar, Ph.D Setenay Sürmelioğlu
02	Draft_V2	10/07/2025	Taylan Günay, Ph.D Özge Andiç Çakır, Ph.D Fırat Sarsar, Ph.D Setenay Sürmelioğlu
03	Draft_V2.1	16/08/2025	Taylan Günay, Ph.D Özge Andiç Çakır, Ph.D Fırat Sarsar, Ph.D Setenay Sürmelioğlu
04	Final Summary	16/09/2025	Taylan Günay, Ph.D Özge Andiç Çakır, Ph.D Fırat Sarsar, Ph.D Setenay Sürmelioğlu



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ACKNOWLEDGEMENTS

This document is a deliverable of the DIGITAL RESILIENCE Project co-funded by the Erasmus+ Key Action 2 under the 2024-1-ES01-KA220-HED-000252797 grant agreement



1. INTRODUCTION

The Digital Twins for Climate Resilience project aims to support higher education (HE) and vocational education and training (VET) students and professionals in the construction and engineering sectors by developing digital twin (DT) skills and knowledge to address challenges in these sectors arising from climate change.

Work Package 2 (WP2) focuses on developing a structured curriculum that combines DT fundamentals, data management, and climate resilience-based use. It includes the creation of three learning pathways with nine modules, supported by real case analyses, interactive exercises, and activities for both higher education (HE) and vocational education and training (VET). This report aims to describe the process and final outcomes of Work Package 2 (WP2) activity of Curriculum Design for Digital Twins for Climate Resilience.

The curriculum consists of three learning pathways as determined in the project description for different needs in higher education (HE) and vocational education and training (VET) students and professionals:

Pathway 1: Introduces DT and basic skills, including understanding what a digital twin is and how it could support a climate resilient approach, also identifying data sources and collection methods. Learning to use basic DT tools and platforms, and preparing organizations for digital-twin adoption and data management are subsequent modules.

Pathway 2: Focuses on the effects of climate change, mostly on wind and thermal impact. The pathway includes defining DT scenarios for these conditions, interpreting simulation results to improve resilience, and exploring good practices from successful projects.

Pathway 3: It is mainly for educators, program coordinators, and institutional members rather than students. It provides an integration guide that shows how the DT curriculum can be included in institutions (Higher Education and VET systems) and other related programs. The final module (Module 9) presents examples of curriculum adaptation.

As the course targets both HE/VET students and professionals, the same content is offered in **two different approaches**. For young and future professionals (for students), a weekly plan is suggested with indicated time, whereas a self-paced, non-sequential approach with reflective questions is suggested for professionals.

This document also explains how partners worked on composing the curriculum by including a review of 44 cases, partner meetings, drafting, stakeholder feedback, and additional independent peer review, thus it explains the progress.



2. OBJECTIVES

This report gathers all the work implemented under WP2, and provides the results for Activity A2.2 "CURRICULUM FOR 3 LEARNING PATHWAYS". Within this deliverable the following project results are provided:

- **Stakeholder Engagement Summary (A2.2/PR1):** A summary outlining the key findings and insights gathered from interviews and questionnaires with the target group and stakeholders regarding future and young professional (F/YP) learning needs.
- **Validated Curriculum:** will consist of the final version of the Curriculum designed and Validated through the quality assurance process. It will reflect the work on both results:
 - Curriculum Structure Document (A2.2/PR2): A comprehensive document defining the structure of the curriculum, including learning goals, teaching methods, lesson topics, module structure, and format of training materials needed for each learning pathway.
 - Quality Assured Curriculum (A2.2/PR3): A refined and quality-assured curriculum based on feedback from stakeholders and subject matter experts, ensuring its relevance, accuracy, and effectiveness.
- **Translated Curriculum (A2.2/PR4):** The final curriculum will be translated into the local languages of partner institutions to enhance accessibility and adoption among the target audience. This will be provided in a separate file per language.

3. METHODOLOGY

The curriculum design phases followed a systematic process that is consistent with the methodology and the tasks described in WP2 of the project proposal:

- **Task 1. Stakeholder engagement:** Organize interviews and questionnaires with the target group and stakeholders to gather first-hand input on the F/YP learning needs.
- **Task 2. Learning pathways:** Design the 3 learning pathways tailored to different skill levels and interests, covering introductory modules to DT, specialized training on wind and thermal variation, and practical guides.
- **Task 3. Curriculum structure:** Definition of the learning goals, teaching methods, lesson topics, module structure, and format of the training materials needed to be developed in WP3.
- **Task 4. Quality assurance:** Review and refine the curriculum based on feedback from stakeholders and subject matter experts, ensuring relevance, accuracy, and effectiveness.
- **Task 5. Translation:** Translation of the final curriculum into the local languages of partner institutions to facilitate accessibility and adoption.



4. THE PROCESS

4.1 Background knowledge

The work developed in A2.1 and A2.2/T1 were the base for the final Curriculum presented in this deliverable.

4.1.1 Needs Analysis and Stakeholder Input

Before designing the curriculum, a detailed needs-analysis survey was carried out in Spain, Portugal and Turkey as described in A2.2/T1. The study targeted future professionals (students), young professionals (recent graduates), and stakeholders, including educators, researchers, and industry experts, to understand their awareness, skills, and expectations related to digital twins and climate resilience.

The results gathered from questionnaires and interviews across partner countries showed that although 74% of respondents were aware of DT technology, only 38% had used it, and 26% had attended any related training. The findings confirmed the necessity for a three-pathway curriculum combining introductory content, specialized modelling training, and institutional integration guides.

4.1.2 Foundation and Review (Analysis of real cases)

A review of existing Digital Twin curricula that were conducted to identify trends in structure, modules and their hours, and competencies, although this part has not directly included the tasks in the proposal, as a supportive study. The DigitalResilience consortium had previously examined the developed case studies on real-world DT implementations by reviewing 44 documented cases as a part of activity A2.1. To prioritize curriculum topics, these 44 real-world DT implementations were analysed and categorised the reported barriers into 9 main challenge types.

Fig. 1 shows the frequency of each challenge type, highlighting cost and resource constraints and interoperability/integration as the most prevalent, followed by technical complexity, data quality and real-time performance. Less commonly reported issues are sensor/IoT limitations, regulatory and privacy hardinesses, skills and knowledge gaps and organizational resistance against changes. This evidence helped the selection of modules and emphasized the need to address both technical and organizational readiness in the curriculum.



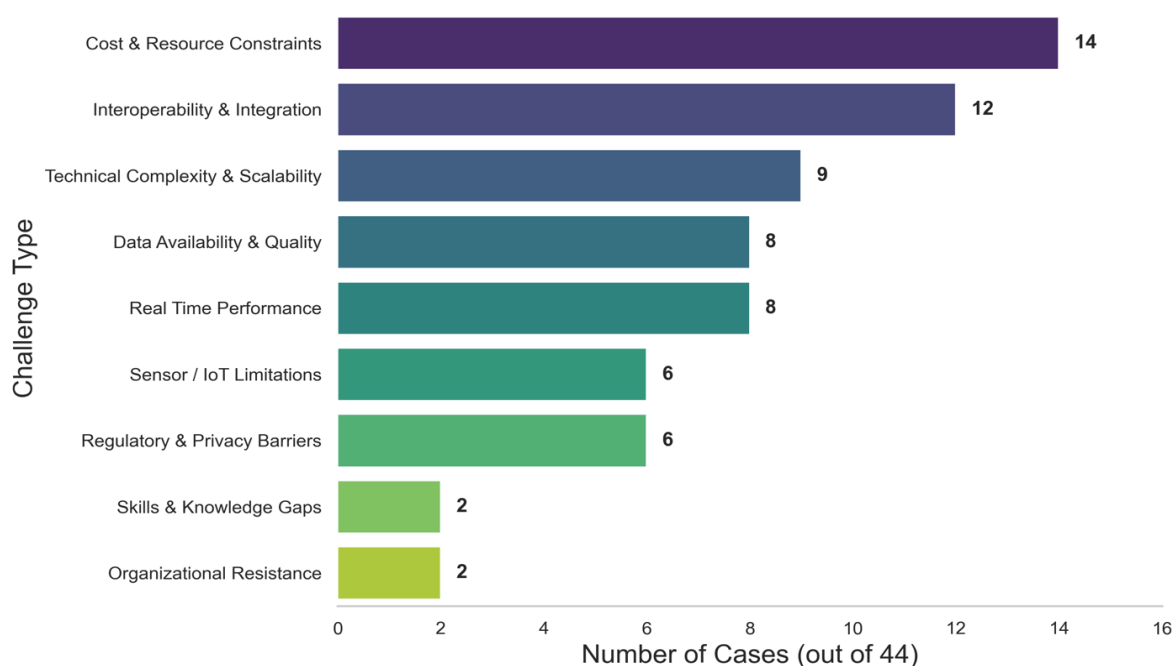


Figure 1. The frequency of challenges reported in real cases.

4.2 Curriculum Design: Learning Pathways and Structure

Based on the previous work, a draft version of the curriculum was developed and structured into three learning pathways and nine modules. The internal reviews among the DigitalResilience consortium refined module content, duration, and learning outcomes. The final “internal stage version” was completed and shared across partners for validation.

4.3 Curriculum Validation

For Curriculum validation national and regional stakeholders were reached. Stakeholder feedback was collected through online or in-person consultations and discussion meetings. Comments and suggestions were analysed, prioritised, and integrated into the curriculum in a follow-up partner meeting. This iterative process ensured the curriculum’s relevance, applicability, and adaptability to different educational contexts.

4.4 Translation and Finalisation

After the validation phase, the final version of the curriculum was translated into the languages of the partners, namely: Spanish, Portuguese, and Turkish, to ensure accessibility and adoption across all participating countries, as described in Activity A2.2/T5.

The final curriculum (English), structured into the three learning pathways, is presented in sections 5 to 9 of this report



5. DIGITALRESILIENCE CURRICULUM: STRUCTURE

Course Title: Digital Twins for Climate Resilience

Course Objective: The Digital Twins for Climate Resilience course aims to introduce digital twin (DT) technology to future and young professionals (F/YP) in the construction and engineering (C&E) sectors, equipping them with the necessary knowledge and skills. At the end of the course, participants will gain a deep understanding of digital twin technology and its climate-specific applications in the construction and engineering sectors.

Learning Outcomes:

LO1: Define the concept, scope, advantages, and limitations of digital twin (DT) technology.

LO2: Identify the significance of DT technologies in the construction and engineering (C&E) sectors.

LO3: Describe data collection methods and tools, and address related ethical, legal, and integration challenges.

LO4: Explain the use of DTs in wind and thermal impact analysis.

LO5: Evaluate the integration of DT technologies into higher education institutions (HEIs) and vocational education and training (VET) environments.

Course Target Group: Students in higher education (HE) and vocational education and training (VET), and early-career professionals in the field of civil engineering, along with educational institutions, project leads and managers in the construction field aiming to integrate digital twins into their curricula and practices.

Prerequisites: Basic software & internet literacy, introductory-level construction/engineering vocabulary

Learning Profiles & Approach: This curriculum serves two learner profiles: (i) HE/VET students and (ii) active professionals. Although the learning content is the same, the approach will differ depending on the type of learner:

Students (HE/VET): Modules are structured with weekly time indications and a suggested sequence. **End-of-module assessment:** Knowledge checks such as quizzes, matching, and similar activities.

Professionals: Fully self-paced, non-sequential; can pick the topics needed. **End-of-module assessment:** Consists solely of self-reflective questions.



6. DIGITALRESILIENCE CURRICULUM: LEARNING PATHWAYS

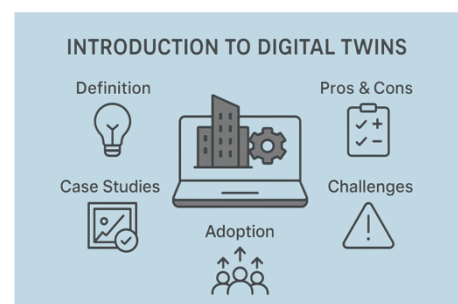
6.1 Pathway 1- Introduction to digital twinning

This pathway introduces the fundamental concepts of digital twinning including what Digital Twins are, how they work, and how they are applied. It aims to build an understanding with identification of data, tools, and organizational readiness.

Module 1- Introduction to Digital Twins (1 week, 3 hours*)

CONTENT:

- What is a Digital Twin? Scope and Definitions.
- Advantages and challenges
- Examples of successful implementations.
- Introduction to Scenario Development and Modelling
- *End of module assessment.*



Module 2 - Data Collection (1 week, 3 hours*)

CONTENT:

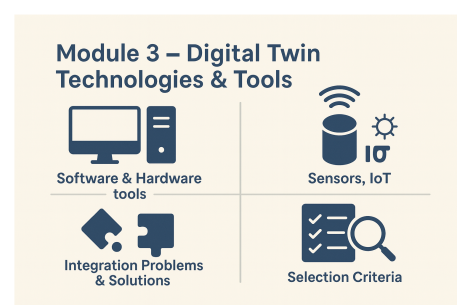
- Identify data sources & tools
- How to collect data (practical methods, formats, instruments)
- Using data within the legal framework (GDPR etc.)
- *End of module assessment.*



Module 3 - Digital Twin Technologies and Tools (1 week, 3 hours*)

Content:

- Digital twin software and hardware tools.
- Sensors, IoT and integration
- Overview of DT tool categories, reliability and selection criteria (usability, cost, support).
- *End of module assessment.*



Module 4 - Preparation of the Organization (1 week, 2 hours*)

- Assessing organizational readiness and needs.
- How to adapt to new digital technologies
- *End of module assessment.*



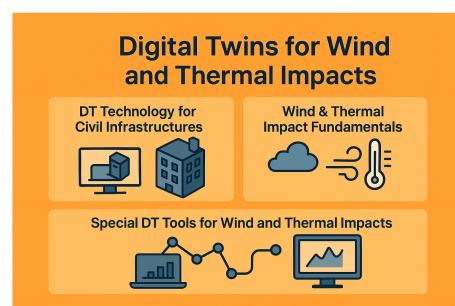
6.2 Pathway 2- Specialization Training: Wind/Thermal Impact Analysis

This pathway explores the application of DT technologies for wind and thermal impacts. The combination theory and practice to model, interpret, and improve climate resilient infrastructures by investigating the case studies.

Module 5 – Preparing Digital Twins for Wind/Thermal Impacts (1 week, 3 hours*)

Content:

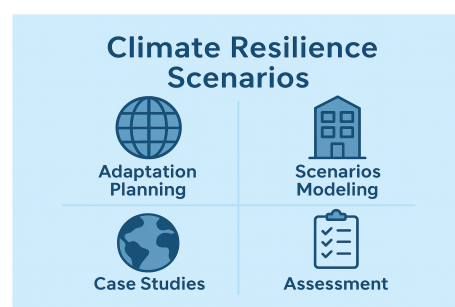
- DT tools and technology for Wind/Thermal analysis.
- Wind & Thermal Impact Fundamentals.
- Specific data sources and sensors input.
- *End of module assessment.*



Module 6 – DT Modelling for Climate Resilience (1 week, 3 hours*)

Content:

- Scenario definition for Wind/Thermal Impact's analysis.
- Wind/Thermal Digital Twins modelling.
- Digital Twin Calibration
- Case Studies of Climate-Resilient Infrastructure for Wind/Thermal effects.
- *End of module assessment.*



Module 7 – Improving towards Climate Resilience (1 week, 2 hours*)

- Interpreting results for Wind/Thermal analysis
- Defining and testing new solutions for Wind/Thermal analysis to enhance results.
- Assessing Institutional Readiness for digital twin.
- Integrating Digital Twins into Education and Institutional Practices.
- *End of module assessment.*



Module 8 – Best Practices/experiences (1 week, 3 hours*)

- Real-world examples of successful DT cases for Wind/Thermal analysis.
- Explore experience sharing, sector-based case studies.
- *End of module assessment.*

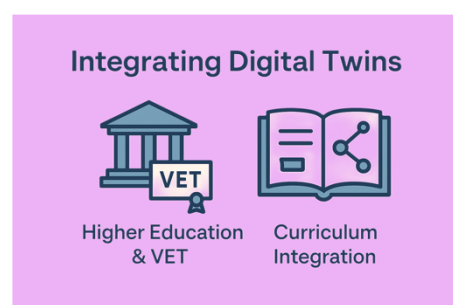


6.3 Pathway 3- Guides for HEI and VETs Integration

This pathway is intended for educators and institutions aiming to integrate Digital Twin methodologies into higher education (HE) & vocational training systems (VET) and related institutional contexts.

Module 9 - Integrating Digital Twins into Education and Professional Development (1 week, 2 hours*)

- The role of Digital Twins in Higher Education and VET systems.
- Examples of curriculum integration.
- *End of module assessment.*



** Suggested duration only for higher education use.*



7. CURRICULUM TABLE (3 LEARNING PATHWAYS)

This section presents the structure of the curriculum. It shows how each module corresponds to the intended learning outcomes, main topics, and estimated duration throughout the three learning pathways.

MODULE	RELATED LO	TITLE	CONTENT	ESTIMATED DURATION
M1	LO1	Introduction to Digital Twins	• What is a Digital Twin? Scope and Definitions. • Advantages and challenges • Examples of successful implementations. • Introduction to Scenario Development and Modelling	1 week
M2	LO3	Data Collection	• Identify data sources & tools. • How to collect data (practical methods, formats, instruments) • Using data within the legal framework (GDPR etc.)	1 week
M3	LO2	Digital Twin Technologies and Tools	• Digital twin software and hardware tools. • Sensors, IoT and integration • Overview of DT tool categories and selection criteria (usability, cost, support).	1 week
M4	LO1, LO2, LO3	Preparation of the Organization	• Assessing organizational readiness and needs. • How to adapt to new digital technologies	1 week
M5	LO2, LO4	Preparing Digital Twins for Wind/Thermal Impacts	• DT tools and technology for Wind/Thermal analysis. • Wind & Thermal Impact Fundamentals. • Specific data sources and sensors input.	1 week



M6	LO2, LO4	DT Modelling for Climate Resilience	• Scenario definition for Wind/Thermal Impact's analysis. • Wind/Thermal Digital Twins modelling. • Digital Twin Calibration • Case Studies of Climate-Resilient Infrastructure for Wind/Thermal effects.	1 week
M7	LO5	Improving towards Climate Resilience	• Interpreting results for Wind/Thermal analysis • Defining and testing new solutions for Wind/Thermal analysis to enhance results. • Assessing Institutional Readiness for digital twin. • Integrating Digital Twins into Education and Institutional Practices.	1 week
M8	LO2, LO5	Best Practices/experiences	• Real-world examples of successful DT applications. • Explore experience sharing, sector-based case studies.	1 week
M9	LO5	Integrating Digital Twins into Education and Professional Development	• The role of Digital Twins in Higher Education and VET systems • Examples of curriculum integration	1 week

Total Duration: 9 weeks - 24 hours*

**Suggested duration for higher education use.*



8. ASSESSMENT METHODOLOGY

In order to provide an adequate Assessment Methodology for the development of the Learning Platform (A3.4) in WP3, the following table describes the assessment tools and approaches identified to evaluate the progress of the learners at the end of each module according to their learner profile (HE/VET students or professionals). This strategy will be adapted and implemented within WP3 according to the feedback from target agents specially in through piloting activities.

Assessment Tool	Weight (%)	Description
Self-Assessment	100%	For students (HE/VET): End-of-module assessments may include short quizzes (multiple choice, matching, multiple attempt) graded automatically via LMS. For professionals: Assessments consist solely of self-reflective questions on how to apply the module content to their own practice.

9. PEDAGOGICAL APPROACH

This section shows the teaching and learning strategies applied in the course by indicating active, self-paced, and scenario-based learning supported by practical resources.

100% asynchronous, online self-learning format.

Active methods include:

- Scenario-based prompts (choose/apply)
- Case study exploration (with guiding questions)
- Self-reflection tasks (short writing or checklist-based only for professionals)

Supplementary resources: downloadable checklists, templates, and case briefs.

10. CONCLUSION

The final curriculum is a collaboratively developed, research-based, and stakeholder feedback-based framework aiming to integrate DT technologies into civil and engineering education. It is aimed to build a bridge between academic training at higher education (HE) and vocational education and training (VET) levels and the DT technological innovations.



It also supports both young and future professionals in climate-related challenges by raising awareness and improving their ability to use DT tools by combining the barriers identified in real cases and a flexible learning design.

The curriculum was designed for two main groups: students who follow a structured study path, and professionals who prefer a self-paced, scenario-based format for continuous learning. The three learning pathways, namely introduction, specialization, and integration, help the participants to develop skills step by step, as the curriculum ranges from basic understanding to the use of DT tools, and finally to institutional implementation. In this way, the curriculum contributes to the digital and climate-resilient transformation of both individuals and educational organizations.

